Free-Flyer Capture Fixtures Standard Committee Overview and ConOps Supplemental Guide Development with MBSE Activity Diagrams Demo

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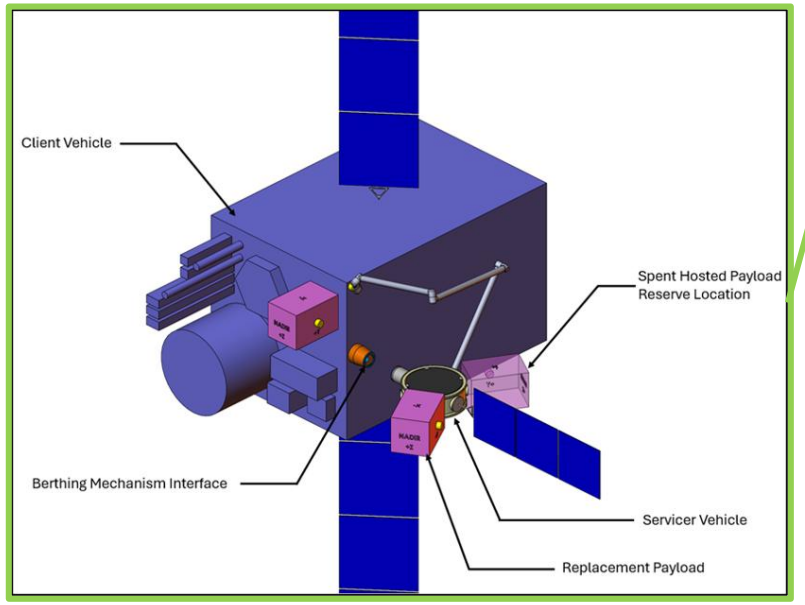
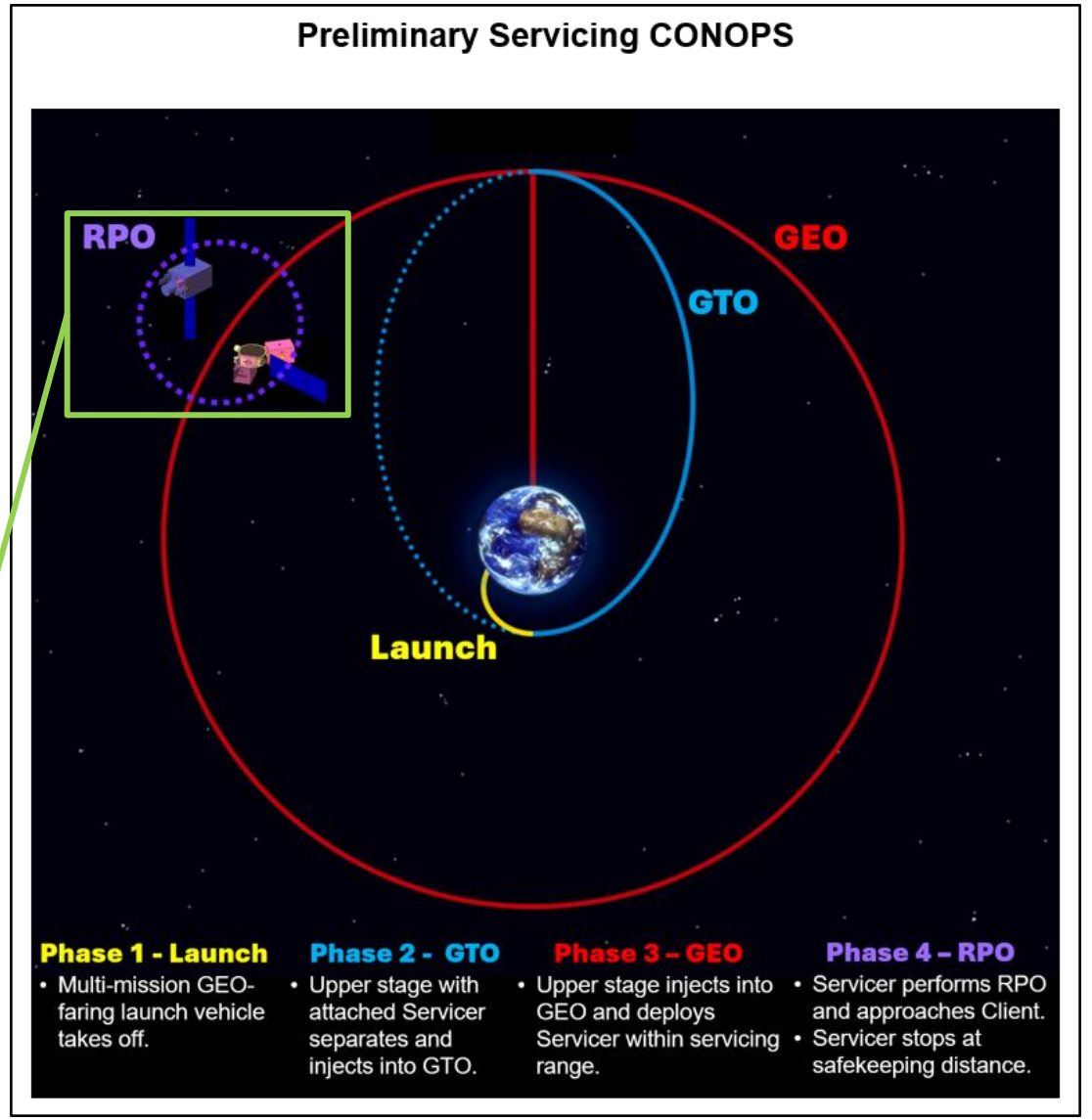
Free-Flyer Concept of Operations (CONOPS) and 3D Model View

- High-value GEO satellites, critical to both national security and commercial operations, typically end their missions when their externally mounted hosted payloads fail or become obsolete
  - Without on-orbit servicing capabilities, operators must accept extended capability gaps until replacement satellites can be launched

- Standardizing the design of a robust, universal berthing device to rigidly connect servicer vehicles to client vehicles would transform mission sustainability by facilitating hosted payload exchanges [1]
  - Extends satellite lifespans, eliminate capability gaps, and enable rapid technology refresh





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Free-Flyer Capture Fixtures Model-Based Systems Engineering (MBSE) Model

- Free-Flyer Capture Fixtures Supplemental CONOPS Guide
  - Describes assumptions for the CONOPS for the FFCF Standard
  - Includes specifications for contractors and subcontractors
- Organized in a modular format
  - Targeted information for stakeholders
  - Subsystem-specific requirements
  - Operational mission flow
- Provides contractors, subcontractors, and developers with clear visibility into deliverables while illustrating their full integration

5.2 Berthed

5.2.1 CONOPS

The following specifications assume autonomous servicing (without ground in the loop). Tailoring for ground-in-the-loop operations should include mission-specific requirements for when, where, and how check-in operations will be performed.

5.2.2 Client

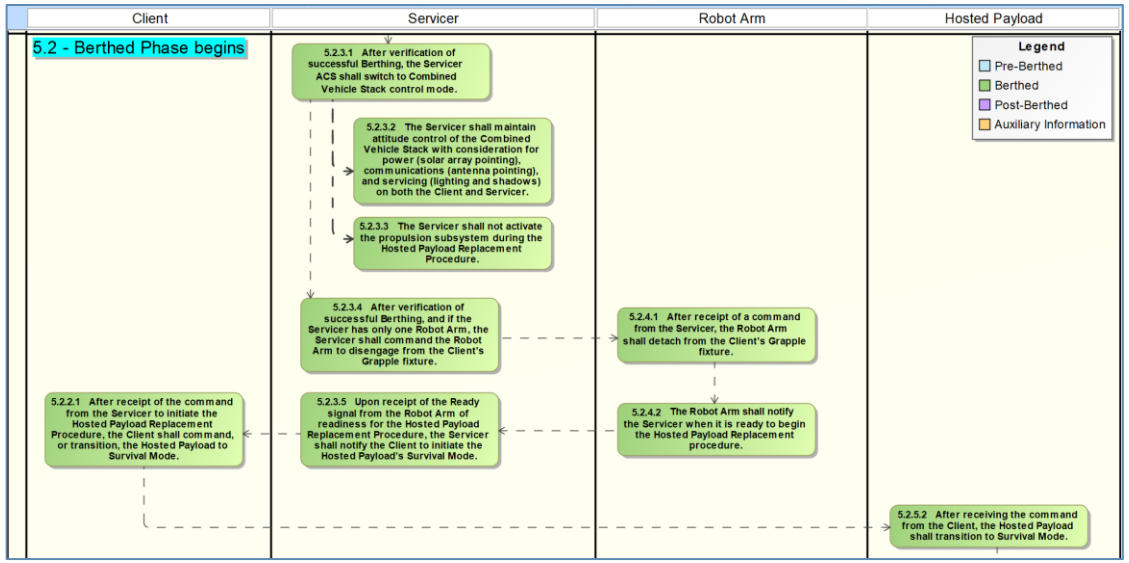
5.2.2.1 After receipt of the command from the Servicer to initiate the Hosted Payload Replacement Procedure, the Client shall command, or transition, the Hosted Payload to Survival Mode.

5.2.2.2 After receipt of a signal from the Hosted Payload verifying completion of its transition to Survival Mode, the Client shall notify the Servicer.

5.2.2.3 After receipt of verification from the Servicer of successful Hard Capture of the Hosted Payload by the Robot Arm, the Client shall notify the Servicer of the prescribed time when power will be removed from the Hosted Payload.

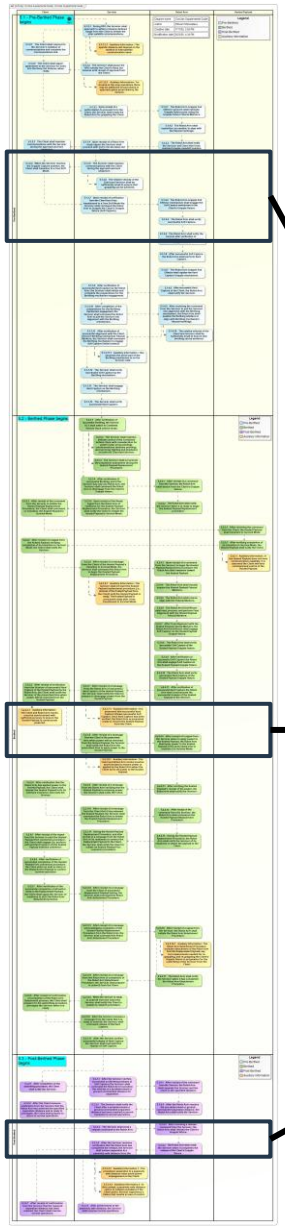
5.2.2.3.1 Auxiliary Information: The Client and Robot Arm clocks must be synchronized with sufficient accuracy to ensure the Hosted Payload is continuously powered.

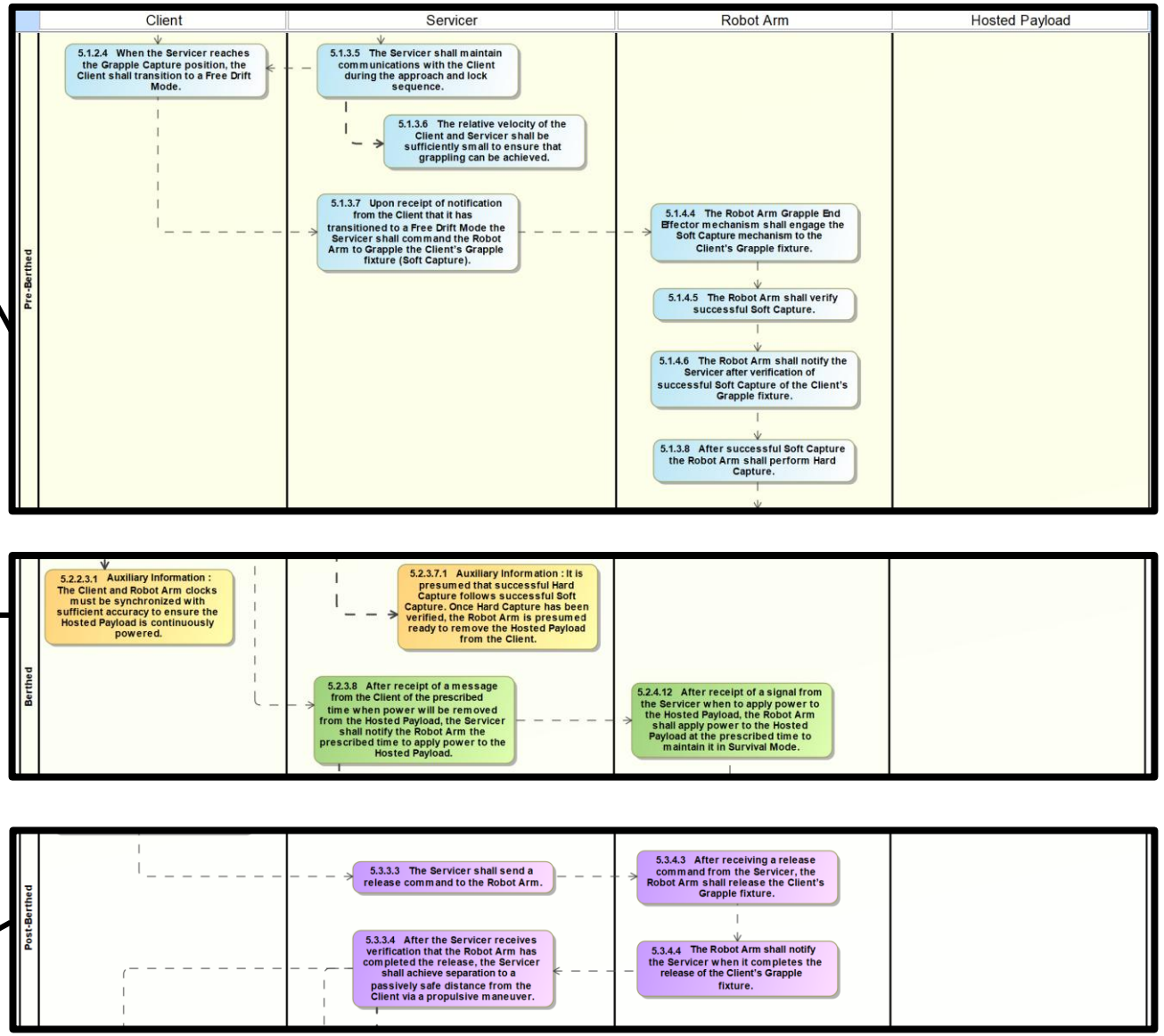
5.2.2.4 After notification that the Robot Arm has applied power to the Hosted Payload, the Client shall release the Hosted Payload from its interface connector and notify the Servicer.



MBSE Model Modular Format

- The MBSE model contains 4 subsystems spanning 3 phases
- Subsystems:
  - Client
  - Servicer
  - Robot Arm
  - Hosted Payload
- Phases:
  - Pre-Berthed
  - Berthed
  - Post-Berthed
- Together, these components detail the entire flow of events of a mission





Free-Flyer MBSE Benefits

- **Parallel Integration** - Model remains the Authoritative Source of Truth (ASOT) through simultaneous development of documents and excel files, maintaining traceability, determining gaps, and providing a single environment where all data is stored

- **Rapid Development** - Quick to create and simple to understand, proven to be a successful MBSE model

- **Stakeholder Clarity** - Transitioned customer discussions from documents to the MBSE model, due to its modular format

References

[1] Space Systems MOSA Interface Standards Alliance, "Supplemental Concept of Operations Guide for MOSA-IF-S-004, Standardized Client and Servicer Berthing Mechanism for On-Orbit Hosted Payload Replacement in Geosynchronous Earth Orbit," ISTO Guide MOSA-IF-G-004, Oct. 2, 2025.